

A survey of the mammal fauna of the Willandra Lakes World Heritage region, New South Wales

C. R. Tidemann

Department of Zoology, Australian National University
G.P.O. Box 4, Canberra, A.C.T. 2601

Present address:

Department of Forestry, Australian National University,
G.P.O. Box 4, Canberra, A.C.T., 2601.

INTRODUCTION

The Willandra Lakes in the semi-arid south-western part of New South Wales are a series of interconnected lake basins that once carried water from a tributary of the Lachlan River towards the Murray. The lakes have been dry for the last 15 000 years. Archaeological discoveries from the Walls of China lunette on the eastern edge of Lake Mungo led to the region receiving international prominence. Human skeletal remains, stone tools, hearths and shell middens from this location provide evidence of human occupation of the region about 40 000 years ago. It thus constitutes amongst the oldest evidence of occupation by modern man anywhere in the world (Bowler and Thorne 1976).

In December 1980 the Willandra Lakes region was nominated by the Commonwealth Government for inclusion on the World Heritage List following a request by the New South Wales Government. The nomination was accepted in October 1981 by the UNESCO World Heritage Committee, which declared the region to be of outstanding universal value and registered it on the World Heritage List. The region is an area of approximately 3 600 km² centred on the Willandra Lakes (Figs 1 and 2).

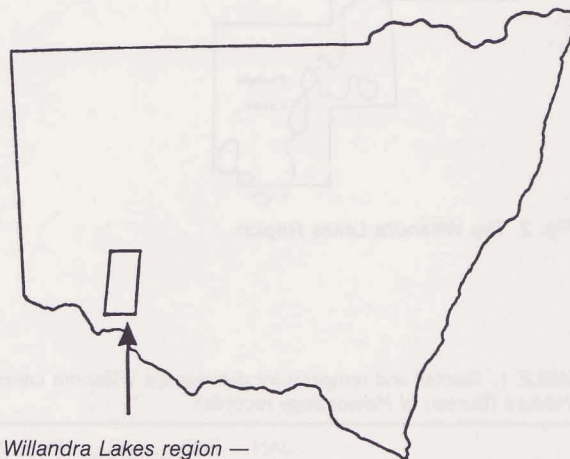
Under the terms of the World Heritage Convention the contracting parties recognize that the cultural and natural properties within their jurisdiction constitute part of the world heritage for which they have a responsibility at an international level. To fulfil the stated obligation towards the identification, protection and conservation of the properties of the region the New South Wales Department of Environment and Planning commissioned a number of specialist studies which will be used to develop a regional environmental plan for the area.

The mammal survey reported here was aimed at this objective — of documenting part of the natural heritage of the region which in itself may not be of outstanding importance, but which is inseparable from the environment and contributes to its character. Few, if any, mammalogists appear to have worked in the area previously, although it is possible that some of the mammals recorded by Krefft (1865) came from the Willandra Lakes region (see Wakefield 1966).

Study area and methods

The Willandra Lakes region is an area of generally low relief. The lake beds are about 50-60 m above sea level and the surrounding plain rises to about 100 m above sea level. Consolidated dunes (lunettes) are present on the northern edges of the lakes and mobile dunes are present in some locations. The rainfall is low and erratic and the summer is characterized by often extreme temperatures (Table 1).

Surface water is now present at fairly frequent intervals in earth tanks, but in pre-European times would have been restricted to several soaks at the edges of



Willandra Lakes region —
see map Figure 2 for detail

Fig. 1. Location Map.

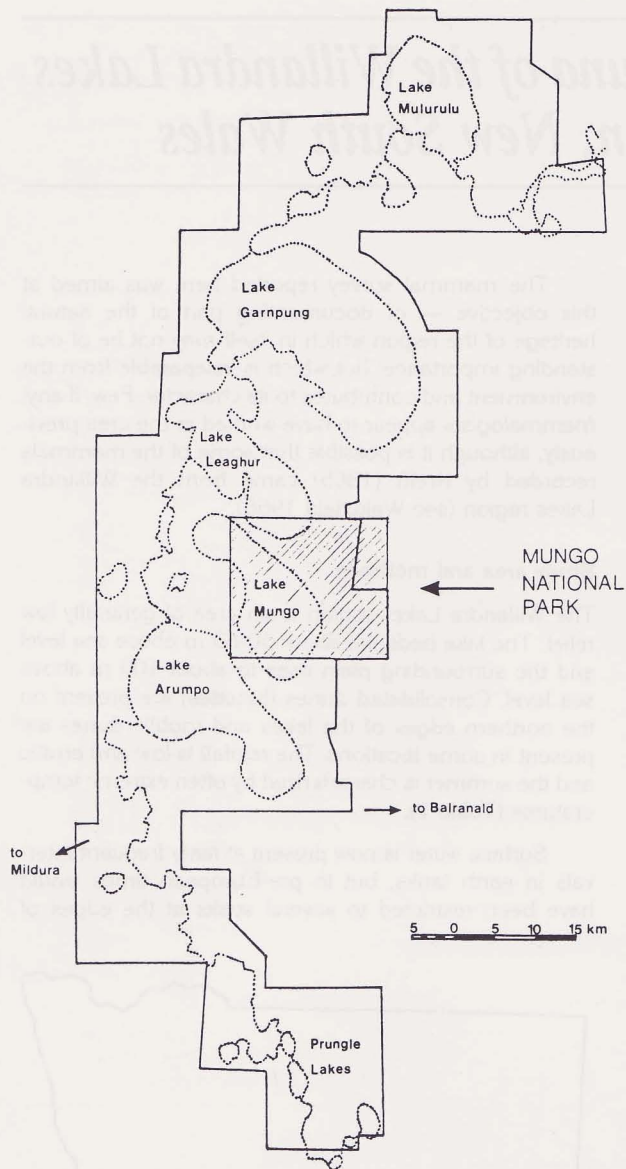


Fig. 2. The Willandra Lakes Region.

dunes, or in the dune systems where the impervious clay substrate lies close to the surface (for example, Garnpang Soak on the north-western edge of Lake Garnpang).

The vegetation of the study area varies from shrub or grass plain through open woodland to mallee. The beds of the lakes are treeless and contain large expanses of cracking soils. Vegetation boundaries in many cases tend to be diffuse and changes between vegetation types are gradual, so that it is difficult to delineate where one begins and the other ends. At the time of the study no description of the vegetation was available. An assessment of wildlife habitat was made by inspection from a light aircraft, of aerial photographs and by vehicle traverse of selected portions. The region has been occupied by Europeans for a little over 100 years. The main activity is sheep grazing, although some cultivation for cereal crops has been carried out on some of the lake beds. Serious overstocking has led to severe sheet erosion of the soil in some places and the grazing pressure has probably also resulted in marked changes to the vegetation.

The following broad vegetation groupings were used as the basis for sampling:

a. areas with trees:

- (i) mallee (various species of *Eucalyptus*) with either predominantly *Stipa* or predominantly *Triodia* understorey;
- (ii) open woodland (various tree species, *Callitris*, *Casuarina*, *Heterodendrum*, *Myoporum* and others) with predominantly *Stipa* understorey, but some areas with small shrubs; and
- (iii) eucalypt woodland.

b. areas without trees:

- (i) perennial saltbush and *Bassia* of various species;
- (ii) *Eragrostis* or other, mainly on cracking soils; and
- (iii) mobile sand dunes and consolidated edges, predominantly *Nitraria*.

TABLE 1. Rainfall and temperature data for the Willandra Lakes area. Rainfall data are from Arumpo and temperature data are from Mildura (Bureau of Meteorology records).

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Mean rainfall (mm)	19	18	16	18	28	25	19	23	21	25	19	19	250
Mean No. of raindays	2	2	2	3	4	5	4	5	4	4	2	2	39
Mean daily max. temp. (°C)	32.1	31.0	28.1	23.8	18.7	16.4	15.3	17.0	20.0	24.1	27.3	29.5	23.6
Mean daily min. temp. (°C)	16.9	16.4	13.7	10.5	7.3	5.1	4.3	5.4	7.3	10.1	12.4	14.6	10.3

Sampling points were chosen so that they lay well within relatively homogeneous stands of the particular habitat being sampled, rather than by selecting the sometimes more diverse ecotones, for these were vague and in many cases difficult to define.

Three periods of field work were spent in the area: a reconnaissance visit of one week in late October 1984 during which vegetation was assessed and sampling points selected; the main survey period of two weeks in November 1984; and a subsidiary sampling period of one week in April 1985.

In an area the size of the Willandra Lakes World Heritage region one is faced with inevitable compromise between sampling intensively and extensively within the constraints imposed by time and budget. In the event, effort was concentrated on the central portion of the region to minimize commuting time and to utilize the facilities at Mungo homestead within the national park. Two field camps were also set up: at Roy's Tank to the west of Mungo H.S. and at the northern end of Lake Garnpang. All major vegetation types were considered to occur in this region.

Attention was concentrated on small terrestrial mammals and bats; other groups of mammals tend to be relatively conspicuous in flat, open areas such as the Willandra Lakes.

Small terrestrial mammal sampling

At each chosen sample point a trapline was set up and left in place, generally for two nights. Each line was based on a plastic drift fence 50 m in length and 30 cm high, the bottom 3 cm of which were buried in the soil. At regular intervals along each line five pitfalls (25 cm in diameter \times 60 cm deep) were sunk into the soil with a mechanical auger and lined with bottomless steel liners. Ten Elliott small mammal traps (9 cm \times 9 cm \times 32 cm) were also placed uniformly along each fence line. Both Elliott traps and pitfalls were baited with a mixture of peanut butter and rolled oats.

Small mammal trapping was carried out at 37 different sites, the locations of which are shown in Figure 3. The dates of trapping and the vegetation associations at the sites are summarized in Table 2. Full details of map references are located in Tidemann (1985).

Predator scat analysis

Scats of predators (fox, cat, goanna) were actively searched for during all survey operations carried out in daylight. The location and source animal were recorded at the time of collection. The identity of prey animals in the scats was determined in the laboratory following standard procedures (Brunner and Coman 1974).

TABLE 2. Small mammal trapping in the Willandra Lakes World Heritage Area (see Fig. 3 for locations).

Trapline number	Dates trapped	Vegetation association
1	16-17.11.84	<i>Casuarina</i> woodland
2	16-17.11.84	<i>Casuarina</i> woodland
3	17.11.84	<i>Casuarina</i> woodland
4	17.11.84	<i>Casuarina</i> woodland
5	17.11.84	<i>Casuarina</i> woodland
6	17.11.84	<i>Casuarina</i> woodland
7	18-19.11.84	Sand-dune, <i>Nitraria</i>
8	18-19.11.84	<i>Atriplex nummularia</i>
9	18-19.11.84	<i>Eragrostis</i>
10	18-19.11.84	<i>Eragrostis</i>
11	20-21.11.84	Mallee
12	20-21.11.84	Mallee
13	20-21.11.84	Mallee
14	20-21.11.84	Mallee
15	20-21.11.84	Mallee
16	20-21.11.84	Mallee
17	23-24.11.84	Mallee
18	23-24.11.84	Mallee
19	23-24.11.84	Mallee
20	23-24.11.84	Mallee
21	23-24.11.84	Mallee
22	23-24.11.84	Mallee
23	25-26.11.84	<i>Eucalypt</i> woodland
24	25-26.11.84	<i>Eucalypt</i> woodland
25	25-26.11.84	<i>Eucalypt</i> woodland
26	25-26.11.84	<i>Eucalypt</i> woodland
27	25-26.11.84	<i>Eucalypt</i> woodland
28	25-26.11.84	<i>Eucalypt</i> woodland
29	27-28.11.84	Lunette
30	27-28.11.84	Lunette
31	27-28.11.84	Lunette
32	27-28.11.84	Lunette
33	27-28.11.84	Lunette
34	27-28.11.84	Lunette
35	9-12.04.85	Perennial saltbush
36	10-12.04.85	Perennial saltbush
37	11-12.04.85	Sand-dune

Bat sampling

Mist-nets were set in position over water bodies before dark, when they were unfurled and then left set until two and a half hours later. Two 18 m monofilament nets were set up over each water body, but in most cases it was necessary to furl one of these shortly after dark in order to reduce the number of captures to a manageable level. Bats were identified and released at the point of capture except for some individuals which were retained for further study.

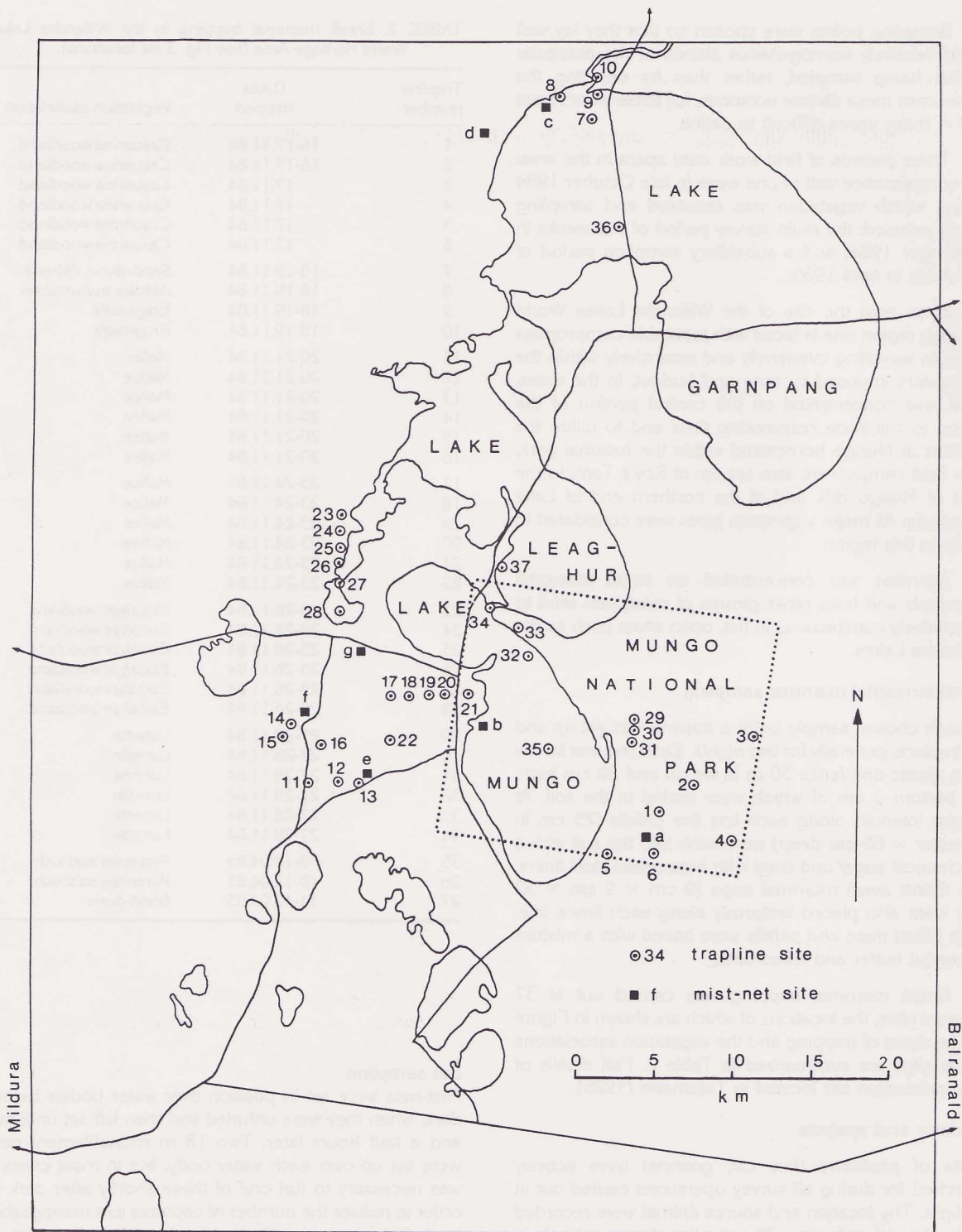


Fig. 3. Portion of the Willandra Lakes World Heritage region showing study site, including when scats were collected.

A summary of mist-netting effort in different vegetation associations is provided in Table 3 and the locations of sampling points are shown in Figure 3.

Harp traps were not used in the survey as suitable trap locations were too uncommon to make their use profitable. One species, which was not captured, was identified from its audible echolocation calls, distinctive appearance and flight behaviour.

TABLE 3. Summary of mist-netting for bats in the Willandra Lakes World Heritage Area. Grid references refer to the 1:250 000 map SI 54-8 POONCARIE (see Fig. 3 for locations).

Location	Grid reference	Dates	Vegetation
a. Everbar Tank	XH9959	27.10.84	Mallee/woodland
Everbar Tank	XH9959	28.10.84	Mallee/woodland
Everbar Tank	XH9959	16.11.84	Mallee/woodland
Everbar Tank	XH9959	10.04.85	Mallee/woodland
b. Mungo H.S. Tank	XH8967	17.11.84	Saltbush/woodland
c. Scrubby Tank	XJ9307	18.11.84	Saltbush/woodland
d. Garnpang Soak	XJ8704	19.11.84	Sandhill/mallee
e. Roy's Tank	XH8163	20.11.84	Mallee/woodland
Roy's Tank	XH8163	09.04.85	Mallee/woodland
f. Double Tanks	XH7768	24.11.84	Mallee/woodland
g. Poo Poo Tank	XH8172	25.11.84	Woodland

Spotlighting

Spotlighting from a vehicle with a 100 watt spotlight was carried out whilst commuting between mist-net sites and camp sites, but it was not done in a systematic way through all vegetation types as there are thought to be no arboreal mammals in the area, and a separate, more detailed, study was being carried out concurrently on feral and native grazing animals. Any small mammals seen were captured by hand.

Two spotlight transects were made on foot in lunette (dune) vegetation, with two observers, each with a portable 30 watt spotlight, abreast of a third with a 12 g shotgun. The first transect was made from grid reference XH9765 to XH9767 (1:250 000 SI 54-8 POONCARIE) on 11 April, 1985 and the second from XH8975 to XH9073 on 12 April, 1985. Both were begun 30 minutes after it had become completely dark.

Other sources of information

A search was made of relevant literature for distribution records of mammals in the area and a computer search was made of Australian Museum records from an area bounded by latitudes 32°00'S and 33°00'S and longitudes 141°00'E and 142°00'E. Mammals collected during a concurrent herpetological survey using formalin-filled pitfalls were examined and discussions were

several residents of the area: P. Clark, E. Richardson, P. Sharpe and I. Wakefield.

RESULTS

Small terrestrial mammals

The results of the combined pitfall and Elliott trapping are summarized in Table 4. Twenty-nine small mammals were trapped, of which 26 were House Mice, *Mus musculus*. Two further species, *Planigale tenuirostris* and *Sminthopsis crassicaudata* were collected by the herpetologists in pitfalls on Lake Garnpang (near trapline number 36). Local residents reported *S. crassicaudata* as being fairly common and widespread. Its incrassated tail tends to make this species distinctive and difficult to confuse with other mouse-sized mammals.

TABLE 4. Results of pitfall and Elliott trapping: numbers of individuals captured. Data are shown only for those lines which caught animals. In all others nil was captured. Refer to Fig. 3 for location details.

Trapline number	Date	<i>Mus musculus</i>	<i>Sminthopsis murina</i>	<i>Ningauia yvonnae</i>
3	17.11.84	3	—	—
7	19.11.84	2	—	—
8	19.11.84	3	—	—
9	19.11.84	4	—	—
10	19.11.84	7	—	—
12	21.11.84	—	—	2
14	21.11.84	1	—	—
17	24.11.84	1	—	—
18	24.11.84	1	1	—
23	26.11.84	1	—	—
24	26.11.84	1	—	—
26	26.11.84	2	—	—
TOTALS		26	1	2

Predator scat analysis

Fourteen pellets or groups of pellets were found, collected and analysed for mammal remains. The results of these analyses are shown in Table 5. Most scats contained a high proportion of insects and some bird remains. No small native mammal remains were found, but two occurrences of *Mus* were recorded.

Bats

The results of mist-netting are given in Table 6. 187 Bats of seven species were caught and an eighth species was recorded by its echolocation calls and observations of drinking individuals. A colony of *Nyctophilus geoffroyi* was found living in the roof of the house at Mungo homestead, and also examined was a specimen of the Little Red Flying-fox, *Pteropus scapulatus*, which had

TABLE 5. Results of predator scat analysis: species occurrence. Each datum refers to a particular pellet or group of pellets.

Locality	<i>Oryctolagus cuniculus</i>	<i>Macropus</i> spp.	<i>Mus musculus</i>
Garnpang soak	+	—	+
Scrubby Tank	+	—	—
Scrubby Tank	—	—	—
Scrubby Tank	—	—	—
Scrubby Tank	—	—	—
Scrubby Tank	+	—	+
Scrubby Tank	—	—	—
Scrubby Tank	—	—	—
Mallee, Top Hut Station	+	+	—
Lunette, Zanci Station	—	—	—
Lunette, Zanci Station	+	—	—
Roy's Tank	—	—	—
Woodland, Mungo N.P.	—	—	—
Woodland, Mungo N.P.	—	—	—

been captured in a debilitated condition at Mungo H.S. in December 1983 by P. Clarke.

Spotlighting and incidental observations

Spotlighting on foot in lunette vegetation on Mungo and Zanci stations resulted in no sightings of small native mammals. One small mammal only (apart from rabbits) was seen and collected, but it was identified in the hand as *Mus*.

No sign was seen of the small hopping mammal reputed to occur in the area by local residents, either by direct sightings or tracks in the sand. One further *Mus* was collected during spotlighting on a claypan on Lake Garnpang and a *Sminthopsis murina* was caught in the same way at Double Tanks.

Numerous individuals were observed of the Red Kangaroo, *Macropus rufus* and the Western Grey Kangaroo, *Macropus fuliginosus*. One Eastern Grey Kangaroo, *M. giganteus* was seen. Other species commonly encountered were Feral Goats, *Capra hircus* and Rabbits, *Oryctolagus cuniculus*. Foxes, *Vulpes vulpes* and Feral Cats, *Felis catus* were seen, but were not common.

Diggings of the Spiny Ant-eater, *Tachyglossus aculeatus* were observed in mallee on Top Hut Station (grid reference XH7675) and several local residents reported seeing them from time to time.

DISCUSSION

Twenty-two species of mammal were recorded from the study area during the survey, of which one was a monotreme, seven were marsupials and nine were bats. The other five were introduced placental mammals. Indications are that the inventory is fairly complete, despite the relatively brief examination which was made of the area.

By far the most important group of mammals in the area, both in terms of species number and number of individuals, is the bats, of which nine species were recorded. Of these, the Little Red Flying-fox, *Pteropus scapulatus*, is an occasional visitor, whereas the others are, with the best information available, sedentary

TABLE 6. Results of mist-netting effort: number of bats caught. Refer to Fig. 3 for location details.

Location	Date	<i>Chalinolobus gouldii</i>	<i>C. picatus</i>	<i>Nyctophilus geoffroyi</i>	<i>N. timoriensis</i>	<i>Scotorepens balstoni</i>	<i>Eptesicus baverstocki</i>	<i>Mormopterus planiceps</i>	<i>Tadarida australis</i>
Everbar Tank	27.10.84	—	—	—	—	—	1	1	
Everbar Tank	28.10.84	—	—	1	—	—	—	—	
Everbar Tank	16.11.84	23	2	8	1	—	3	2	+
Everbar Tank	10.04.85	2	—	1	—	—	—	3	+
Mungo H.S. Tank	17.11.84	4	1	4	—	1	—	1	
Scrubby Tank	18.11.84	5	3	2	—	—	1	5	
Garnpang Soak	19.11.84	5	1	17	—	2	—	18	
Roy's Tank	20.11.84	3	2	2	—	1	—	+	+
Roy's Tank	09.04.85	1	—	2	—	—	—	2	
Double Tanks	24.11.84	13	7	15	—	5	1	2	
Poo Poo Tank	25.11.84	2	—	5	1	3	—	2	
TOTALS		58	16	57	2	12	6	36	0

+ indicates species was seen, but not captured.

species. The Australian Museum holds two *P. scapulatus* from Ivanhoe, and this species is known to range widely over inland New South Wales (Nelson 1965), following flowering of eucalypts, the blossom of which forms one of its main foods.

From known distribution records (see, for example, Strahan 1983) there are no other species of bats which are likely to occur in the survey area. Reinforcement for the idea that a complete inventory of bat species has been made is that exactly the same suite of species has been recorded from Danggali Conservation Park in South Australia (S. C. Flavel, pers. comm.). Danggali Conservation Park contains similar vegetation to the Willandra Lakes region.

In late November, when the main part of the survey was undertaken, day temperatures were high, adult female bats were lactating and there was a need for them to drink daily. Thus, collections were made at watering sources at this time of year are likely to result in a complete inventory of species. The only species not caught was the White-striped Mastiff-bat, *Tadarida australis*. However, this species has a very loud, distinctive audible call and was clearly identified at two tanks, both from this and from its characteristic size, markings and flight behaviour. The marked difference between bat numbers and species caught in the October and April survey periods and the main November session (Table 6) indicate the changing dependence of bats on water sources with season.

Discussion of habitat preferences of the various bat species would not appear to be justified from the data collected. All species recorded, with the exception of *Pteropus scapulatus*, are dependent on tree holes for diurnal roost sites. The Little Pied Bat, *Chalinolobus picatus*, was at one time thought to be an obligate cave-dweller, but one was caught near Cobar in an area completely devoid of caves or cave surrogates (Tidemann 1978) and Richards (1979) recorded a colony in the wall of a deserted building at Yathong. There are no caves or cave surrogates (mines, tunnels etc.) in the Willandra area, yet *C. picatus* was quite a common species, indicating that it is indeed a tree hole bat, at least in some areas.

Thus all species recorded, with the exception of *Pteropus scapulatus*, are dependent on trees for diurnal roost sites, even though they may forage several kilometres from these. *Mormopterus planiceps* was commonly heard over areas completely devoid of trees, for example Lake Mungo and Lake Garnpang. The fact that most water tanks are constructed in woodland areas, rather than in mallee, where sandy soils predominate, makes it difficult to ascertain whether a particular bat is

roosting in mallee or woodland if both vegetation types are in close proximity to a particular tank. Such was the case at Everbar, Roy's and Double Tanks. Mungo H.S. tank is closer to woodland than to mallee, but it is less than 2 km by air from mallee.

Small terrestrial mammal trapping produced disappointingly few results. Including the two mammals collected by the herpetologists only 31 individuals were trapped, of which 26 were *Mus*. One further native mammal was caught by hand, but it was of a species which had been captured already in a pitfall trap (*Sminthopsis murina*). Predator scat analyses produced no records of small native mammals and few house mice (predator scats themselves were also scarce and only 14 scats or groups of scats were located despite fairly prolonged searching for them).

Hence it seems likely that the small terrestrial mammals recorded are a realistic picture of the fauna at the time of the study. The populations of many arid species, of course, fluctuate widely in numbers with changing seasons. Most exist at low densities except after extensive rainfall, when their numbers may multiply greatly. Further surveys could be undertaken more profitably after several successive good seasons.

The only species of small mammal known to occur in the area but not recorded on the survey, was the hopping mammal reported by several local residents. The most likely candidate for the description supplied appears to be the Kultarr, *Antechinomys laniger*. Specimens have recently been caught at Kinchega National Park (K. Mullette, pers. comm.) and may thus also occur further south. The study area lies within the range predicted for this species by Strahan (1983). Mitchell's Hopping-Mouse, *Notomys mitchelli*, has been collected to the south of the Willandra Lakes region, but it appears to be restricted to mallee (Strahan 1983). The reported sightings of the 'small hopping mammal' in the study area were in vegetation ranging from treeless areas through sand-dunes to mallee, approximating more closely to the recorded habitat preferences of *Antechinomys*.

Planigale gilesi may also occur in the Willandra Lakes region as it is known to occur sympatrically with *P. tenuirostris* further to the north (Strahan 1983), and perhaps *Sminthopsis macroura*.

Habitat quality in the region varies greatly according to fire history, grazing regimes and between the different vegetation associations. Many areas within the region show evidence of gross overstocking in the past, resulting in severe erosion and consequent degradation of the vegetation. Although there is no direct evidence to substantiate the belief, it is thought that many small

mammals have been adversely affected by high stocking rates, both from the trampling effect of ungulate hooves on burrows and other homesites, and because of long-term soil and vegetation changes. Domestic stock damage appears to be least in mallee, probably because in the sandy soils water sources are few and far between. Feral Goats, however, are widely distributed in fairly large numbers in mallee.

In some woodland areas many trees have been ringbarked and although at present the timber is still standing, it will eventually fall and result in the loss of roost sites for bats. Judging by the large numbers of bats present, roost sites are not a limiting factor at this stage. The provision of numerous man-made water sources in the region may well have allowed the proliferation of bats and, perhaps, Grey Kangaroos. The other species present are to a very large extent independent of free water.

The practice of growing cereal crops in this type of marginal country is seen to be absolutely inimical to the preservation of natural resources, including soils, and brings about direct conflict between croppers and wildlife species such as kangaroos and emus. The harvest is poor, is usually limited to a few seasons only, and results in broad scale invasion by weeds.

It is difficult now to determine retrospectively what the mammal fauna of the Willandra Lakes region was prior to European settlement, but it seems likely that a number have disappeared. The Blandowski expedition in 1856-57, about 20 years after the first European settlers moved in, may have made forays into the region, but even this is now uncertain (Wakefield 1966). This expedition collected several species which were widespread at that time, and have now become extinct or extremely rare. Some of these occurred over a wide range of habitat types and were probably present in the Willandra region. Examples are the Western Barred Bandicoot, *Perameles bougainville* and the Bilby, *Macrotis lagotis*. The Eastern Hare-wallaby, *Lagorchestes leporides* was recorded not far away near Booligal in 1890 (Marlow 1958) and the Burrowing Bettong, *Bettongia lesueur* was described by Krefft as being in abundance on the New South Wales side of the Murray (Wakefield 1966).

The reasons for the disappearance of these species are probably multiple. Most of those which have gone were small to medium-sized burrowing or surface-dwelling animals. Hypothesized reasons to account for their disappearance are: changes induced in soil and vegetation by domestic stock, competition by rabbits and predation by introduced carnivores, among others. The correct explanation seems likely to remain shrouded in mystery.

Perhaps there is some consolation in knowing that Krefft recorded only three species of bat, whereas there are now known to be nine in the Willandra Lakes region, and quite a few more if one includes the likely extent of Krefft's collecting. Bats so far seem to have fared better than most mammals since European settlement.

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